Data Center Power Consumption

A new look at a growing problem

Fact - Data center power density up 10x in the last 10 years

- 2.1 kW/rack (1992); 14 kW/rack (2007)
- Racks are not fully populated due to power/cooling constraints

Fact - Increasing processor power

- Moore's law

Fact - Energy cost going up

- 3 yr. energy cost equivalent to acquisition cost

Fact - Iterative power life cycle

- Takes as much energy to cool computers as it takes to power them.

Fact - Over-provisioning

- Most data centers are over-provisioned with cooling and still have hot spots

An Industry at the Crossroads

Conflict between scaling IT demands and energy efficiency

Server Efficiency is improving year after year

Performance/Watt doubles every 2 years

Power Density is Going Up

Annual Growth Rate 4%

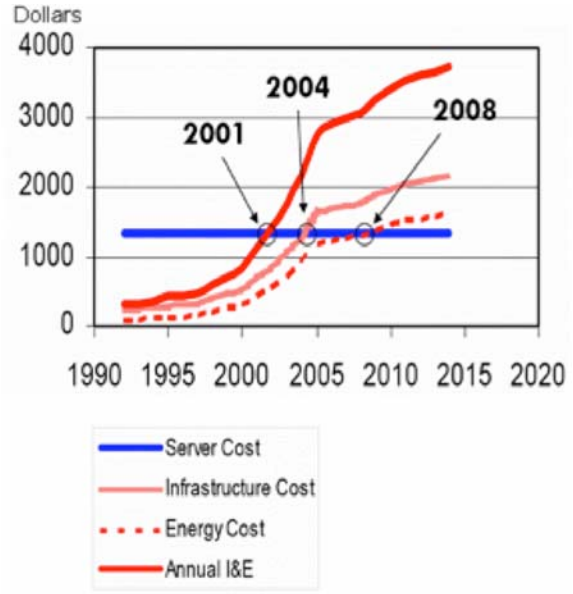
Application growth> Server Performance Growth

Data Centers are not Shrinking

Infrastructure + Energy Costs > Server Costs

I&E Costs are over 2X that of 1U Server in 07'

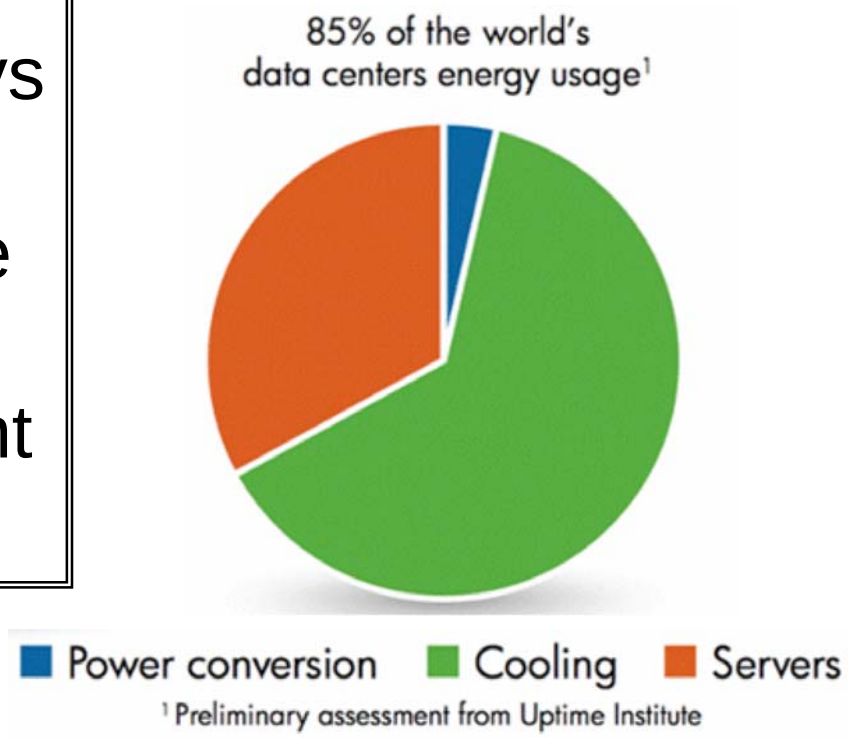
I&E Costs significant part of TCO



Growing pressure from both government and customers to address climate related issues through improved energy efficiency

The greatest gain in reducing kW in data centers is with cooling

While equipment manufactures seek ways to decrease power consumption immediate energy saving can be made with more efficient cooling strategies

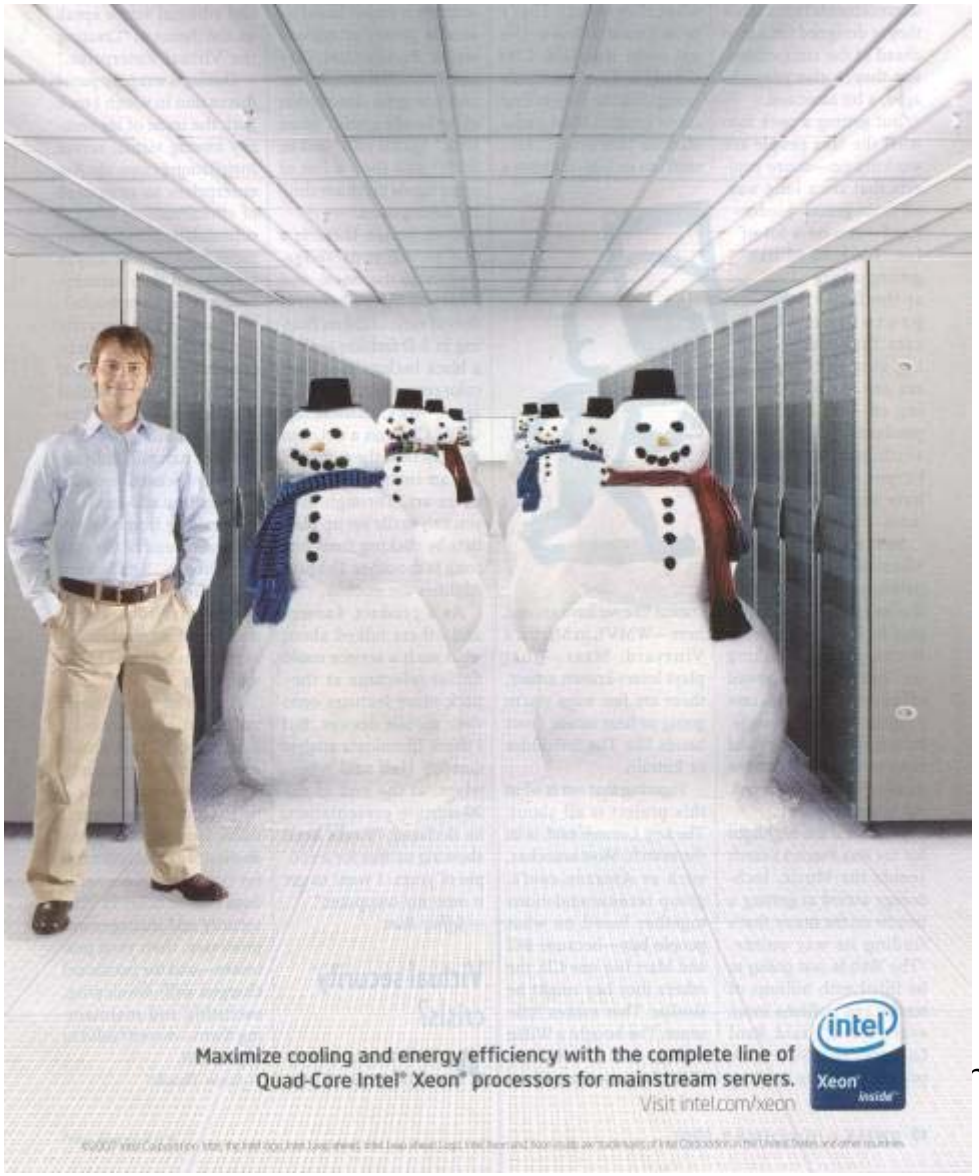


Where is the roadmap to energy savings?

- Every major manufacture is working on a solution according to their product line
  - New and improved CRAC units
  - Monitoring systems
  - Fan powered cabinets
  - Fan powered floors
  - Water cooled cabinets
  - Reduced power computers

Two well know equipment manufacture with ways to lower power consumption in the data center.

Note: the perspective is from their product line…not the entire computing envelope



Which cooling solution should you try?

- Few data centers can afford a sweeping replacement or repositioning of CRAC units
- Most data centers can't replace all of their computer racks or relocate racks to hot/cold aisles
- Impractical to replace all computers with new less energy consuming 'greener' ones
- Most of the room cooling solutions are only a piece of the whole cooling solution

Is there a tool to help you decide which and when to implement cooling energy solutions?

How can you determine where you will get the most energy savings with the least investment?

The Value of Computer Modeling

- Computational Fluid Dynamics -

- CFD's allows for a comprehensive view of the data center cooling arrangement
  - Both existing and proposed
- CFD's see things how they really are
  - Legacy data centers
  - Unusual room sizes
    - Difficult Layout's
    - Small Subfloor depths – low pressure subfloor
    - Bad CRAC unit location
    - Improper hot/cold aisle separation
- CFD's allow you to peer into the future of increased kW
  - Creeping kW - as new units with larger watts replace older units
- Try before you buy
  - See the true effectiveness of proposed solutions
  - Get the biggest gain per dollar spent
- Understand the true limits of a proposed data center

February 16, 2007

Equipment Manufactures encourage the use of CFD's

the green grid™

The Green Grid is a non-profit trade organization of IT professionals formed to address the issues of power and cooling in datacenters

By using Computational Fluid Dynamics (CFD) in the datacenter environment, the designer can optimize datacenter cool air flow by "tuning" floor tiles by varying locations and by regulating the percent of vents that are open at any given time or can optimize CRAC (Computer Room Air Conditioning) unit locations.

Some vendors offer cooling optimization services and have demonstrated over 25% energy savings in real-world applications."

"The ability to predict future power and cooling loads is also key in managing an energy-efficient datacenter."

"Many datacenters have multiple air conditioners that actually fight each other. One may actually heat while another cools and one may dehumidify while another humidifies. The result is gross waste that may require a professional assessment to diagnose."

CFD Modeling allows for the input of the best practices for a healthy data center

How much energy and what effect would your data center experience if you…

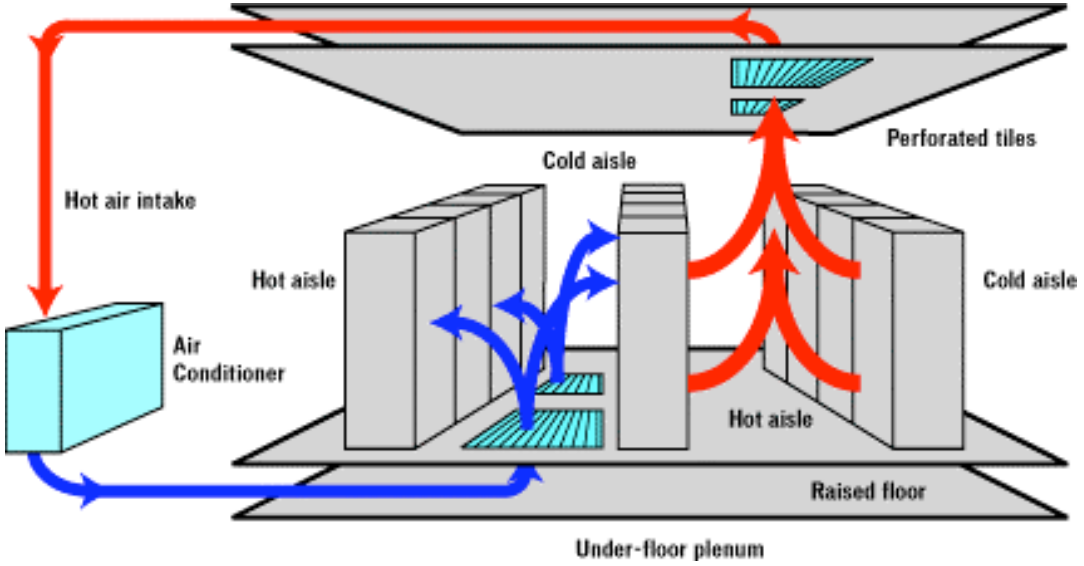
1. Used blanking panels
2. Fill cable cut outs
3. Eliminate high subfloor air velocity
4. Hot aisle/cold aisle
5. Matching server airflow
6. Eliminate rack gaps
7. Use longer rows
8. Orient CRAC units perpendicular to hot aisle
9. Adding another CRAC unit
10. Overhead air conditioning
11. Increased subfloor depth

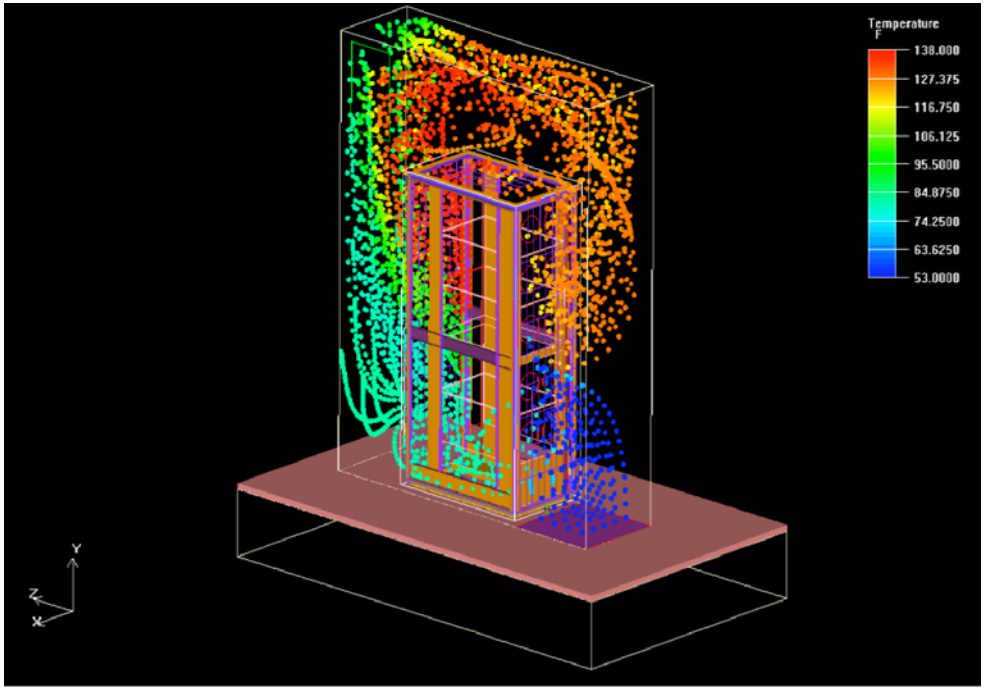
What is the value of Airflow Engineering?

Computer modeling allows the engineer to examine all of the cooling factors and see how they interrelate with one another.

This proven method makes for the best hot and cold air separation.

”



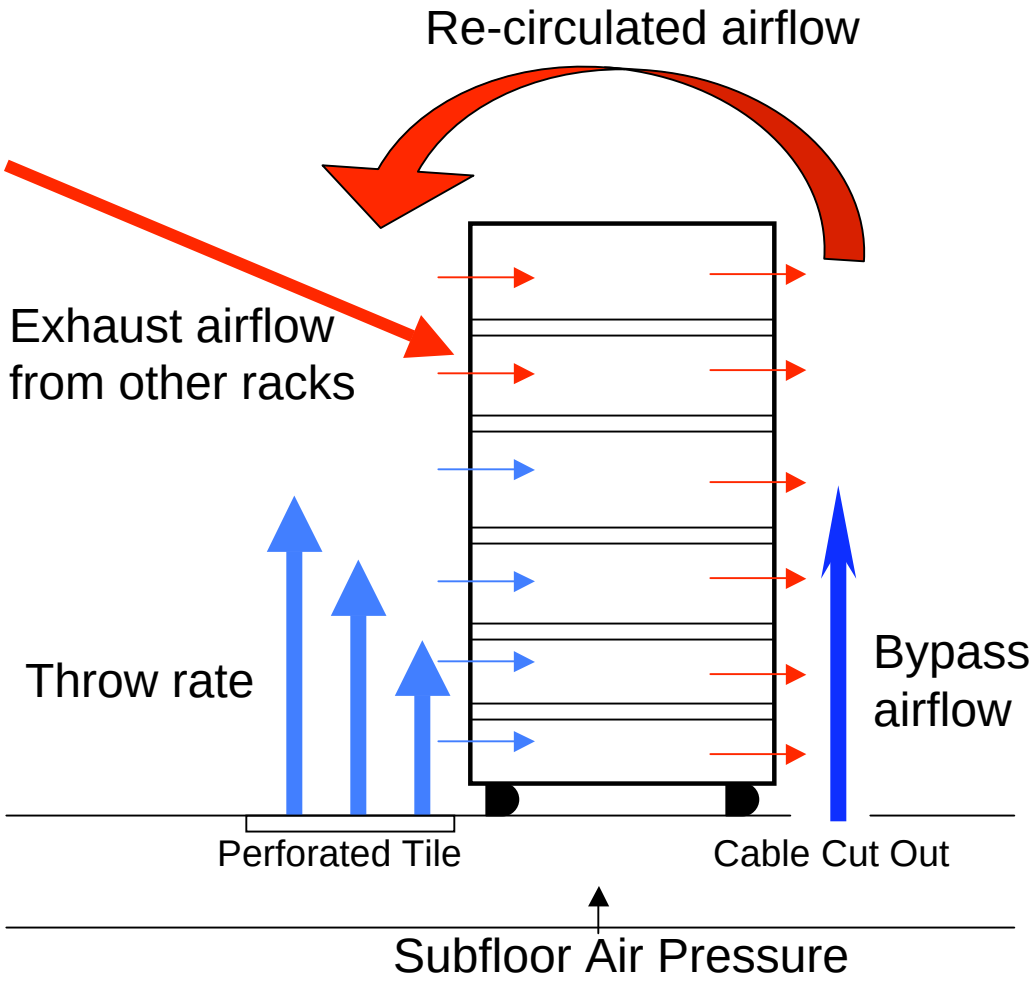


SubZero Engineering

Basics of Airflow Management

Basic areas of concern in data center airflow management include:

- Airflow to the Intake of computers
  - Volume
  - Height
- Exhaust air flow back to the CRAC unit
  - Bypass airflow
  - Re-circulated airflow
  - Balance thermal load to each CRAC



SubZero Engineering

Case Studies

Following are 5 case studies demonstrating the benefits of air flow management in the overall data center cooling program…

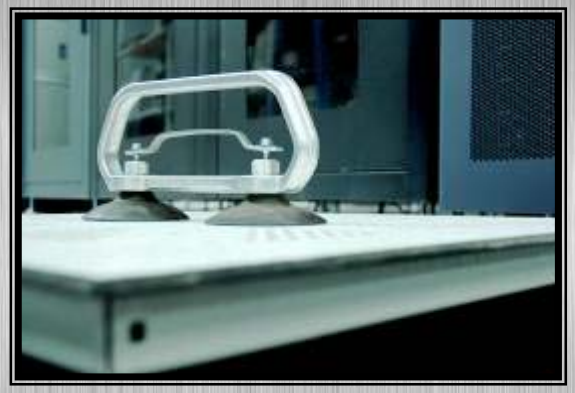
Case Study # 1

Subfloor Pressure

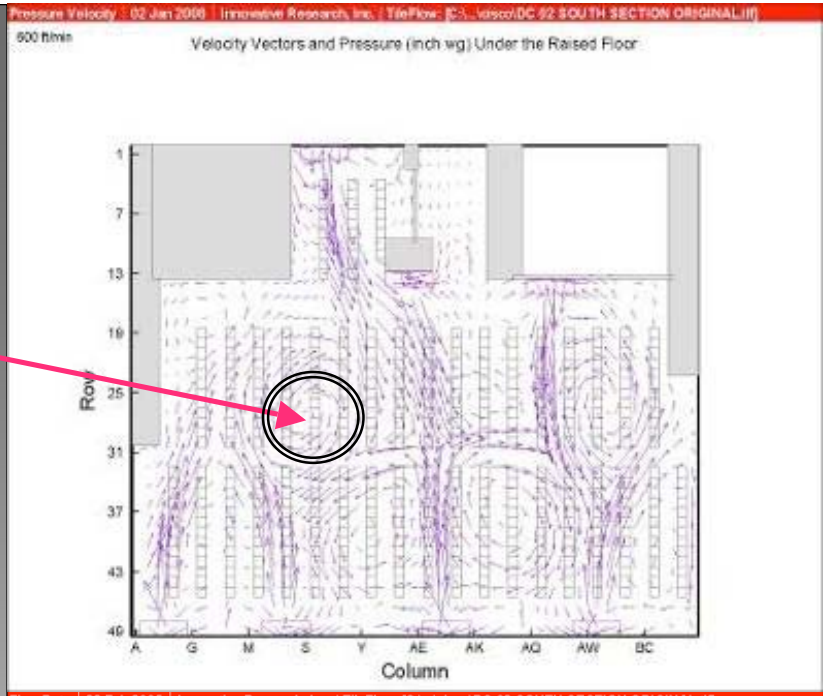
The foundation of every data center cooling solution is the subfloor air plenum.

Excessive velocity in the subfloor (caused by high volume airflow from the CRAC units) creates ‘rivers’ and ‘eddies’ in the subfloor plenum.

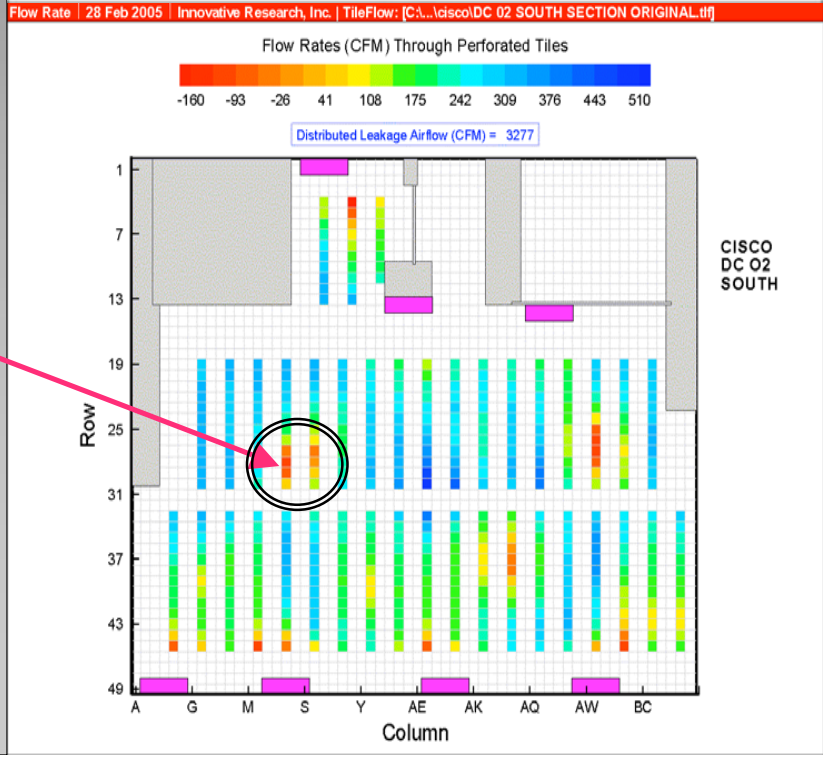
The affect of this velocity is seen in the low flowing areas nearest CRAC units and underneath eddies.



‘rivers’ and ‘eddies’ caused by high velocity



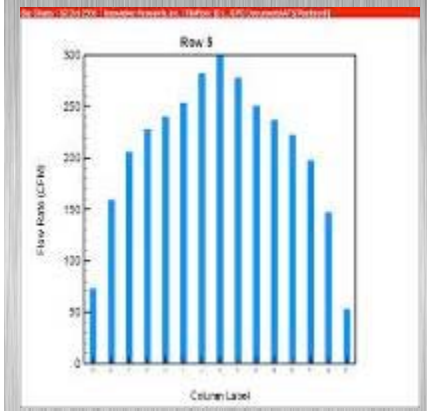
low flow areas

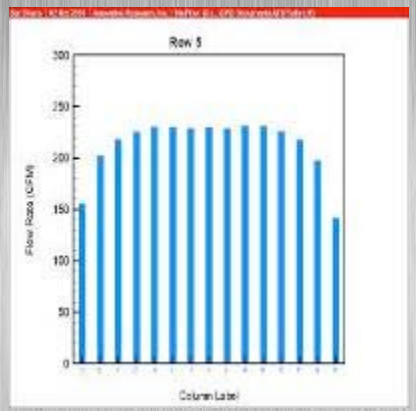


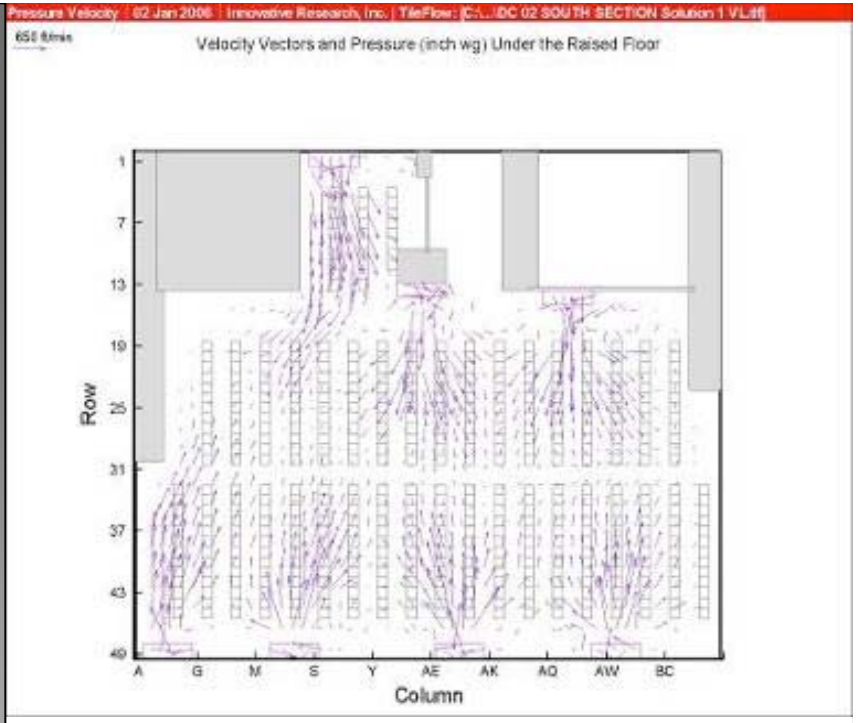
Case Study # 1 (continued)

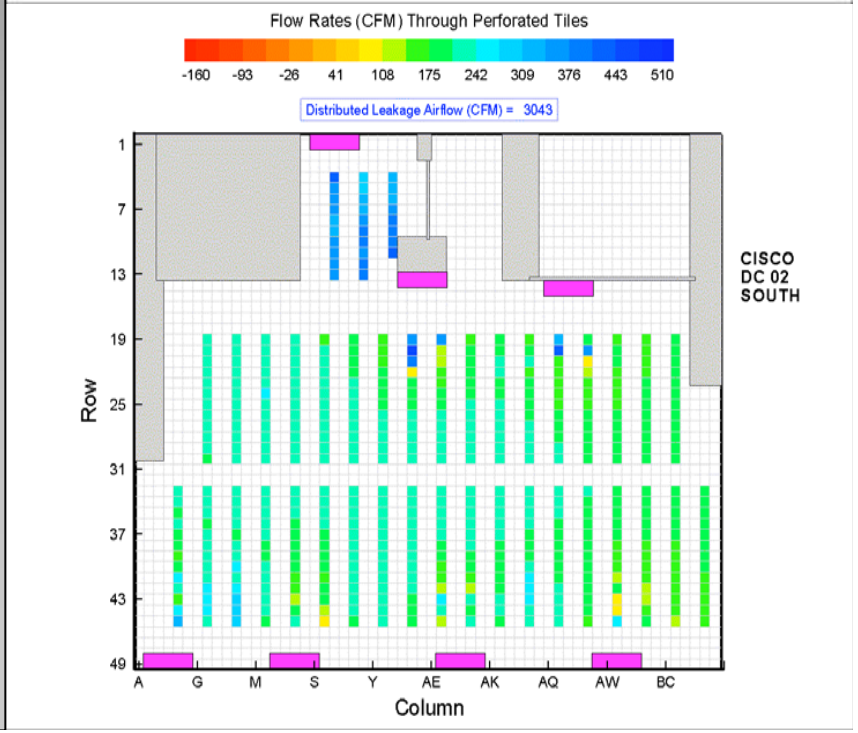
SubZero Velocity Adjustors installed underneath the subfloor plenum slow the air speed thereby increasing air pressure.

Once the subfloor air pressure is balanced the perf tiles will allow a more even airflow throughout the data center.









Case Study # 2

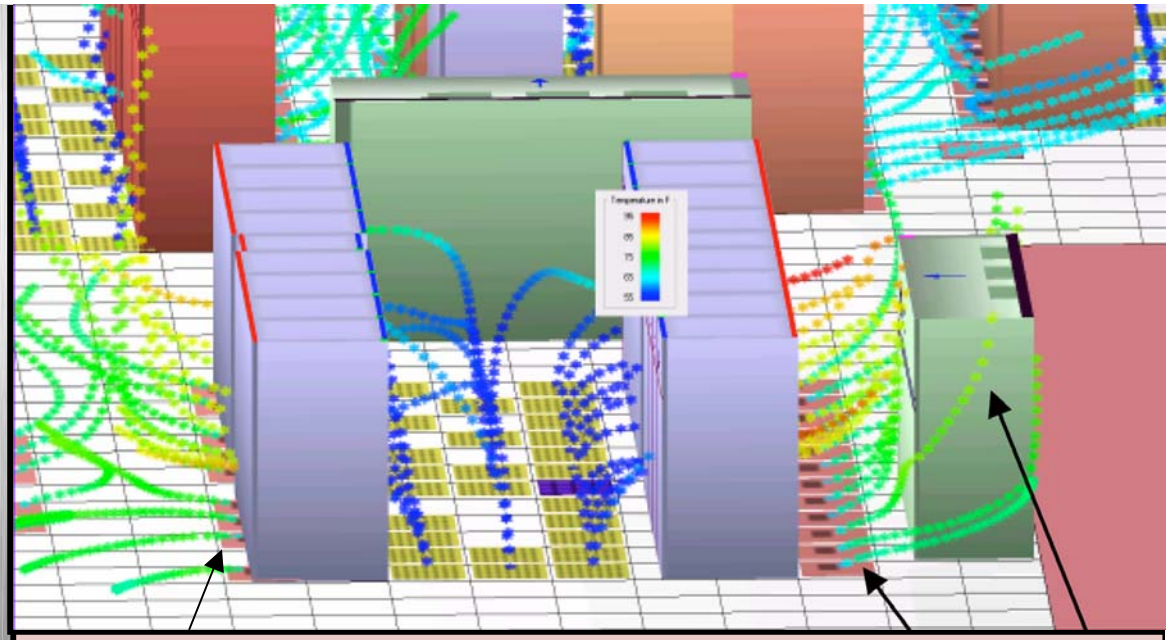
Cable cut out covers

Air coming from the subfloor plenum through an un-managed opening (cable cut outs) will negatively impact your data center in two ways

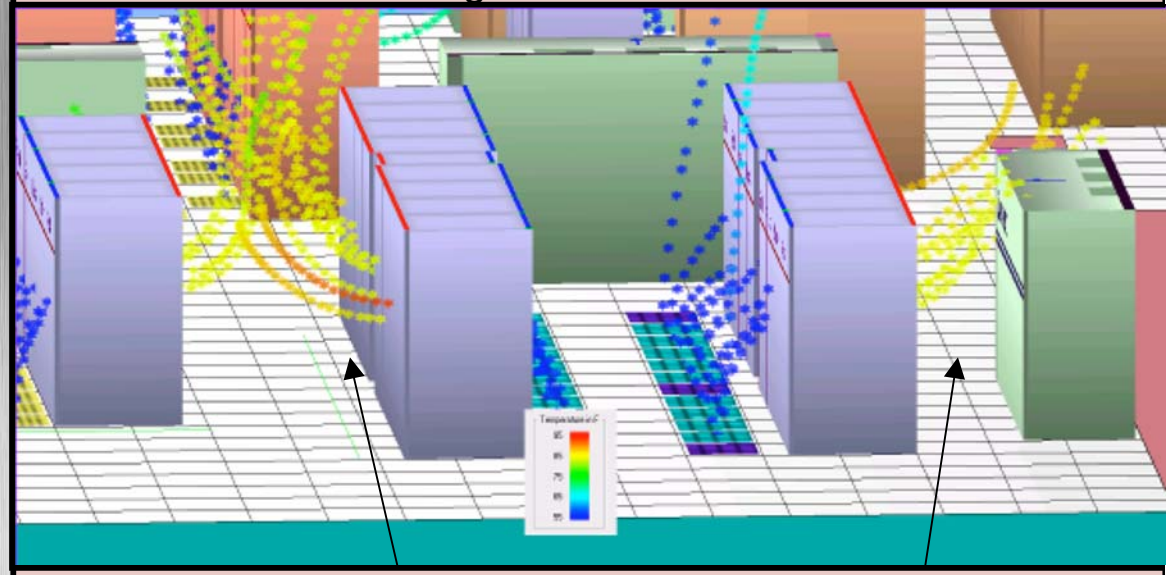
1. decreases subfloor air pressure
2. confuses CRAC intake sensors

Decreased subfloor air pressure hurts the ‘throw rate’.

The CRAC units indicate cooler air and shut down the cooling process affecting rh and leading to demand fighting.



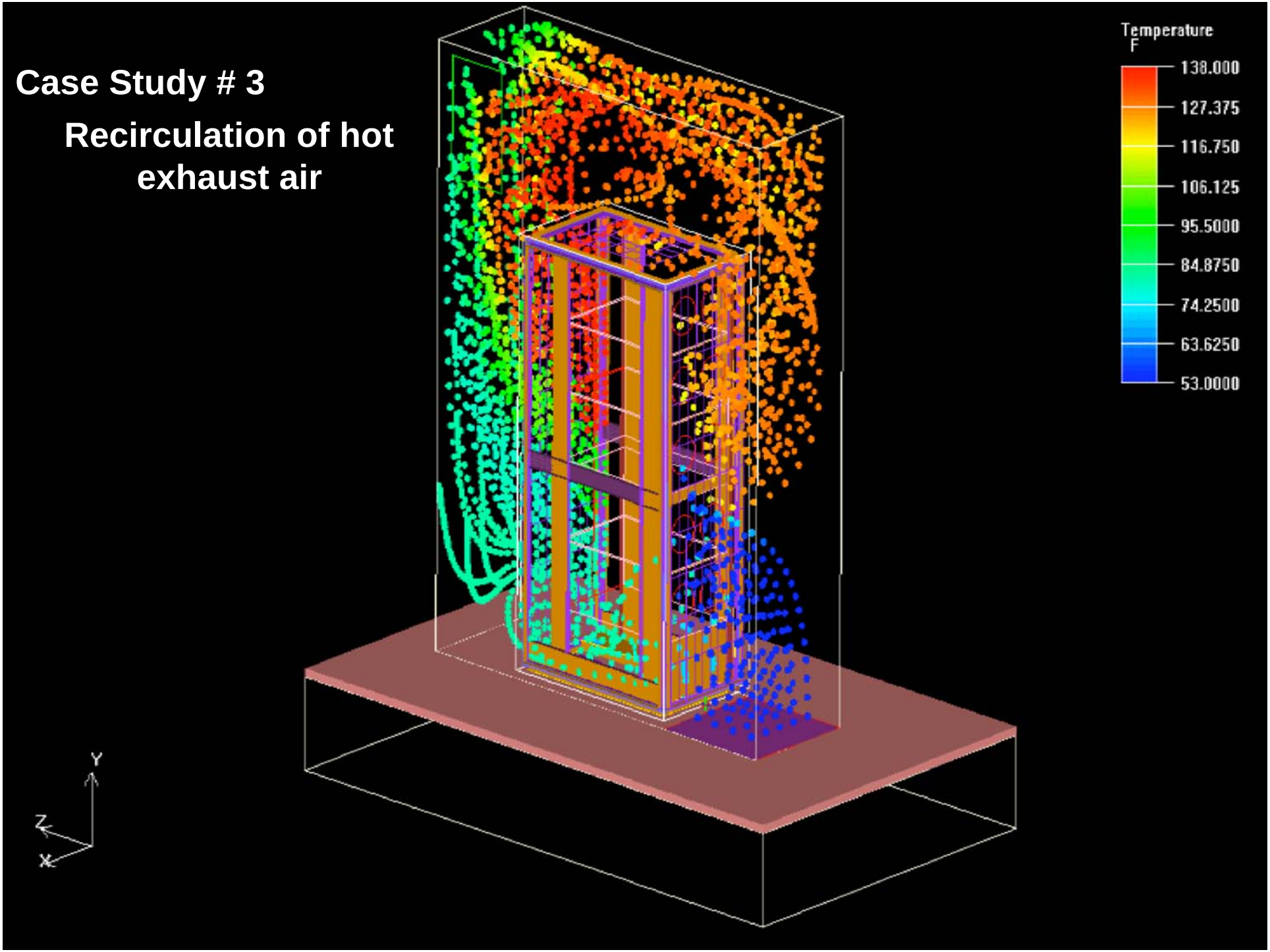
Note the air bypass back to the CRAC without passing through the thermal load



No bypass air! Plus a higher more consistent air temperature returning to CRAC unit.

Case Study # 3

Recirculation of hot exhaust air



Case Study # 3

Recirculation of hot exhaust air

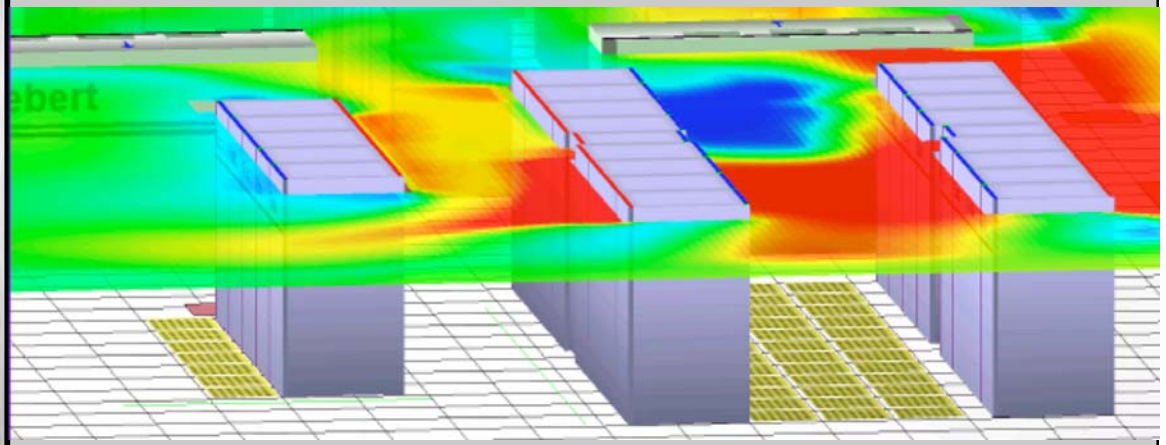
Hot exhaust air moves quickly in the data center due to higher temperature and lower rh. This warm air can easily move back into the intake (cold) aisle.

To correct this we create a CFD to determine the movement and direction of this warm air. The next step is to design a way to direct this movement, including:

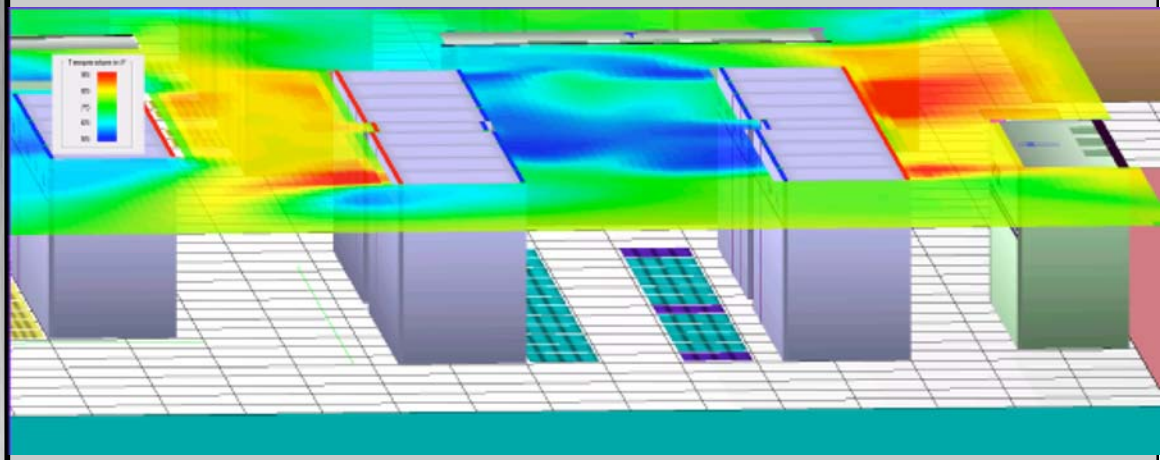
Hot air evacuation systems

Increased air flow tiles

Aisle Isolation systems



Note the hot re-circulated air in the intake (cold) aisle. This is especially prevalent in the upper racks.



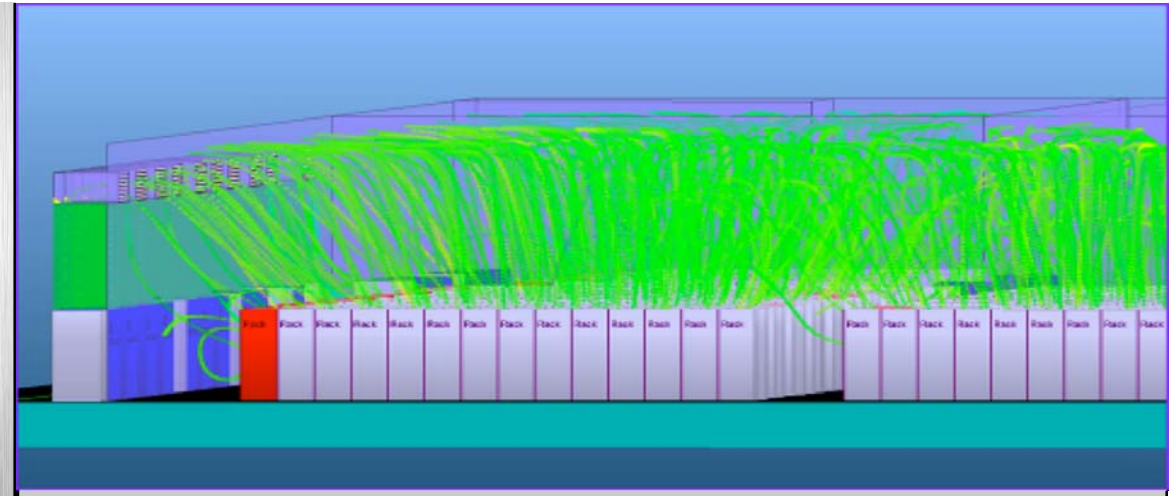
With increased subfloor airflow along with the efficient removal of hot exhaust air racks can be fully populated.

Case Study # 4

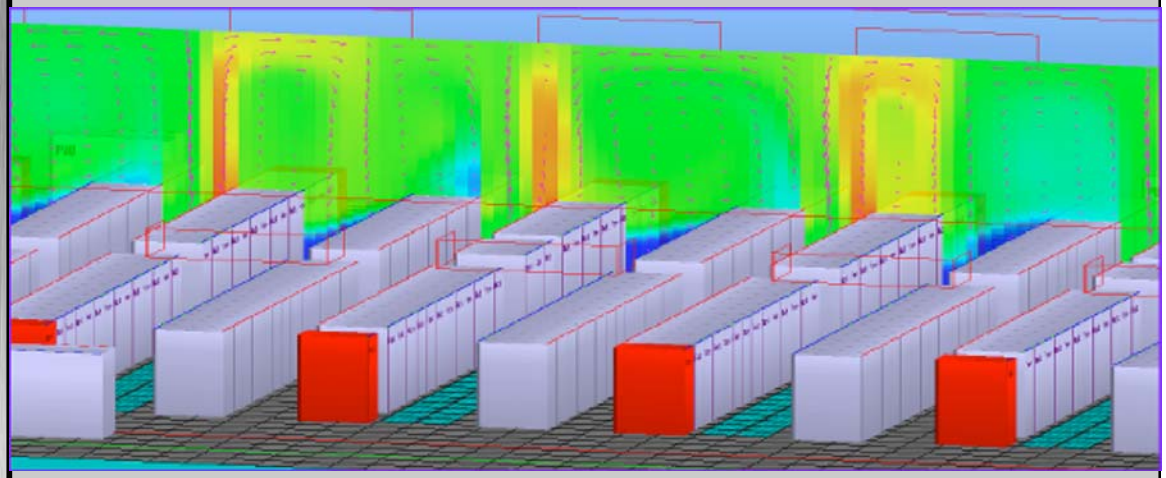
New Construction Design

Even with the advantages of a three foot subfloor plenum and 30 foot ceilings CFD's have proved very effective in exposing key design flaws.

Case in point…



Note the value of the high ceiling…still the return of hot exhaust air to the CRAC required better seperation



This can be seen by the U shape of the hot exhaust air.

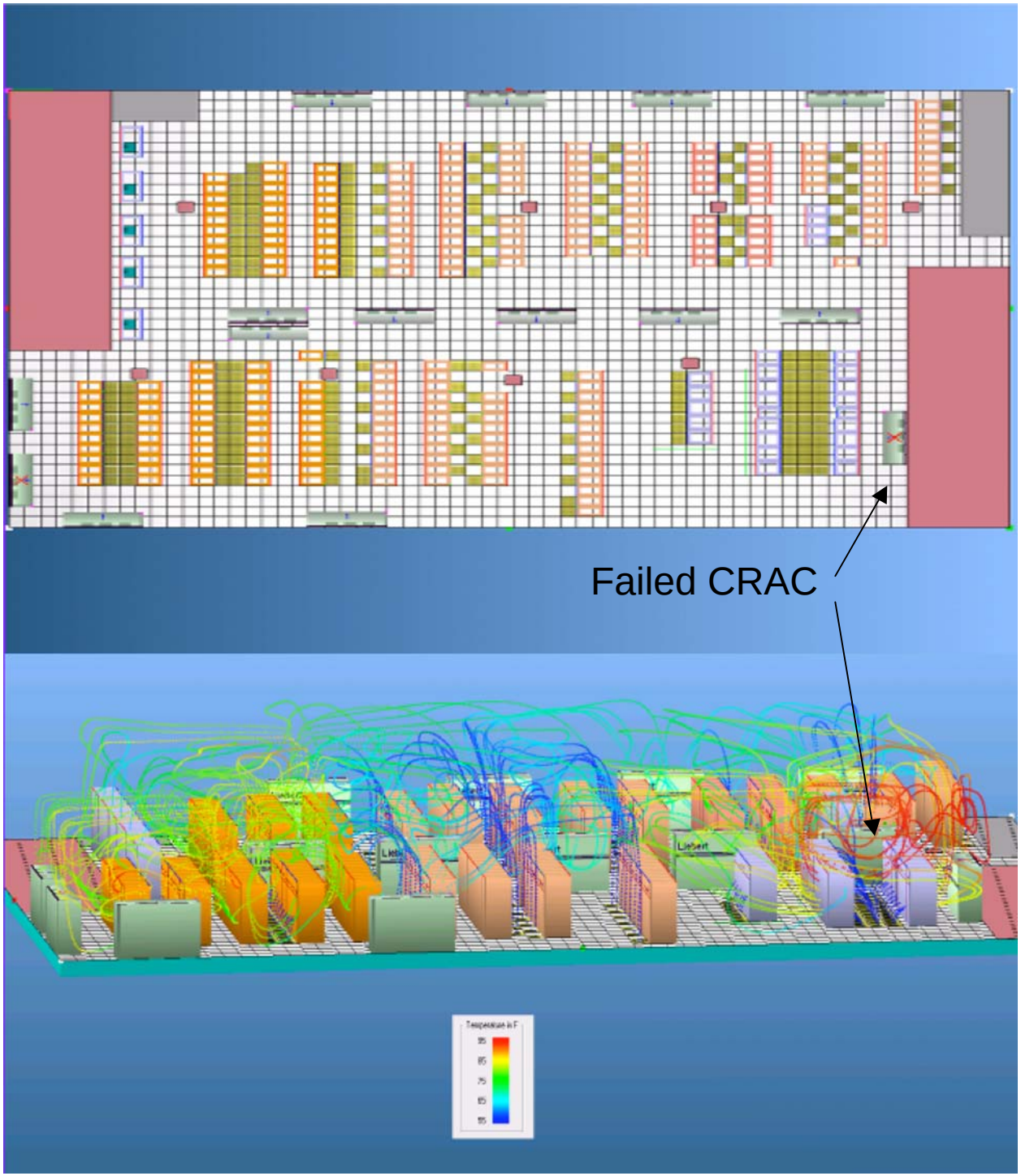
Case Study # 5

Disaster Recovery Planning

- CRAC unit failure -

The affect a failed CRAC unit will have on your equipment largely depends on its location.

A CFD can be used to determine how the failure will impact operations and can help create an effective DR plan.



SubZero Engineering

Delivering a range of energy saving services

Data Center Computer Modeling	On-Site Data Gathering	Engineered Solutions
		
•CFD •Rack and CRAC data •Graphical demonstration	•Rack kW •Room layout •Airflow measurements •Rack/room temperature	•Real world solutions •ROI energy calculator •40 plus page report •Animated airflow movie